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The Effect of Monetary Policy on Short-Term Interest Rates

THE "liquidity effect" plays a central role in Keynesian theory of the transmission of monetary policy. It is based on the notion that the demand for money is negatively related to the nominal interest rate.[1] Other things the same, an exogenous increase in the money stock depresses nominal and real interest rates, stimulating aggregate demand.

Even though theorists acquiesce to the liquidity effect as a theoretical proposition, it is often challenged on efficacy grounds. It is argued that changes in the money stock do not leave all other things unchanged. Monetarists, such as Friedman (1968) assert that the liquidity effect is, at best, only temporary; the ultimate effect of more rapid money growth is higher inflation (or, more importantly, expectations of higher inflation) and, consequently, higher nominal interest rates. New classical economists argue that the real interest rate is determined by basic tastes and technology considerations, which are slow to change.[2] If increases in the money supply primarily affect the market's expectations of inflation, nominal interest rates will rise immediately.

Estimates of money demand equations, especially short-run equations, indicate that money demand is very interest inelastic, suggesting that there is a strong liquidity effect.[3] Most other empirical work, however, has estimated the total effect of changes in monetary policy on interest rates. A wide range of methodologies have produced diverse and sometimes conflicting results. This article is an attempt to consolidate the evidence on the responsiveness of interest rates to monetary changes. Various methods for estimating the relationship between interest rates and monetary impulses are reviewed and then applied to a common data set. Also, the analysis implicitly incorporates the possibility that the money stock is endogenous in the sense that the money multiplier depends on the interest rate.[4]

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[1]Until fairly recently, most forms of money were non-interest-bearing. Consequently, the opportunity cost of holding money was represented by the nominal interest rate. A large portion of M1 now is held in the form of interest-bearing NOW accounts. The opportunity cost of this component of M1 is the spread between market rates and the rate paid on these deposits.

[2]Recently, Niehans (1987) has argued convincingly that the description of the rational expectations school as "new classical economics" is a misnomer. He argues that its emphasis on continuous market-clearing constitutes a fundamental break from both classical and neoclassical economics.

[3]Many economists, for example Carr and Darby (1981), believe the liquidity effect implied by these equations to be implausibly large.

[4]The interest sensitivity of the multiplier is shown in models of the money supply process. For example in Thornton (1982), the behavioral equations are assumed to be linear; thus, although the multipliers are not functions of the interest rate per se, they are functions of the interest elasticities of these behavioral equations.

THE LIQUIDITY EFFECT

The liquidity effect is defined as the interest responsiveness of the demand for money in a simple model of liquidity preference where the money stock is assumed to be controlled directly and exogenously by the monetary authority.[5] For example, consider the following specification of the demand for nominal money

(1) $M^d = L(i, Py), L_i < 0, L_p, L_y > 0,$

where M, i, y and P denote the nominal money stock, the nominal interest rate, real income and the price level, respectively. If the money stock is taken as exogenous, $M^s = M$, the market equilibrium condition is

(2) $M = L(i, Py).$

Hence, the liquidity effect is defined as

(3) $di = (1/L_i)dM.$

While the theoretical relevance of the liquidity effect is acknowledged, analysts generally argue that it may be partially or totally offset quickly by other effects, both direct and indirect, of money stock changes. To see this, assume that the price level is positively related to the money stock and real output is negatively related to the interest rate. That is,

$P = P(M), P' > 0$

and

$y = y(i), y' < 0.$

Substituting the above expressions into equation 2, the effect of an exogenous change in the money stock on interest rates is

(4) $di = (1 - L_pP'y)dM/(L_i + L_yPy').$

This measure reflects not only the interest sensitivity of the demand for money, L_i, but the direct effect of money stock changes on the price level, $L_pP'y$, and the indirect effect of interest rates on income, L_yPy'.

The effect of an exogenous change in money on interest rates given by equation 4 is strictly smaller than the liquidity effect of equation 3 because of the income and price level effects. According to the Keynesian transmission mechanism, the lower nominal and, at this point real interest rate, stimulates aggregate demand and, hence, real income. The rise in real income increases the demand for money, causing interest rates to rise; this mitigates the initial liquidity effect. Equation 4 also incorporates the direct price level or the "Keynes effect". An increase in the nominal money stock causes the price level to rise, which in turn causes the real money stock to decline, resulting in an increase in interest rates.[6]

If money stock changes affect output or prices sufficiently rapidly, then the income and price level effects will offset, at least in part, the decline in interest rates associated with the liquidity effect. Moreover, it may be difficult to find a statistically significant *negative* relationship between changes in the money stock and changes in the interest rate if the data are averaged over a long period.[7] Indeed, if financial market participants anticipate the rise in income or the price level, these effects will be reflected in market interest rates immediately; thus the observed change in interest rates associated with a money stock change might be small even over short time periods.

The "Fisher Effect"

In addition to the income and price level effects incorporated in equation 4, there is also the possibility of the "Fisher effect." Fisher (1930) argued that, in the absence of differences in holding costs, the real, risk-adjusted return on assets should be the same regardless of the units in which the assets are expressed. Consequently, the return on physical assets should be the same as the return on credit contracts denominated in fixed units of nominal money. This implies that the interest rate on dollar-denominated contracts will reflect the

[5]Because the liquidity effect usually is discussed in models where the money stock is assumed to be controlled by the monetary authority, it has become synonymous with the interest responsiveness of money demand. In a model where the money stock is endogenous, it may be more appropriate to think of the liquidity effect in terms of the impact of an exogenous change in monetary policy on interest rates. This would reflect not only the slope of the money demand function, but the slope of the money supply function as well.

[6]For notational convenience, equation 1 is written without imposing the usual assumption that L(.) is linear homogenous of degree one in P.

[7]This may be one reason why Peek (1982) and Wilcox (1983a), Makin (1983) and Hoffman and Schlagenhauf (1985) obtained different results using similar data and methodologies. All used the biannual Livingston survey data on inflation expectations; however, Makin, Hoffman and Schlagenhauf interpolated the data and estimated a quarterly model, while Peek and Wilcox used biannual data.

market's expectation of inflation over the duration of the contract. Hence, if an increase in money growth produces expectations of more rapid inflation, the nominal interest rate will rise.[8] The existence of a contemporaneous price expectation effect mitigates and possibly eliminates the liquidity effect on the nominal interest rates.[9]

The Effect of an Endogenous Money Supply

Until now, the money supply has been assumed to be controlled exogenously by the Federal Reserve. In the modern financial system, however, the total money stock is determined not only by the policy actions of the Federal Reserve, but by the portfolio decisions of depository institutions and the public. That is, the money supply is composed of both "inside" and "outside" money. Generally, there is no sense in which one can measure the effect of a change in the stock of endogenous, inside money on interest rates.[10] Instead, the effect of monetary changes on the interest rate is measured in terms of changes in outside money.

For example, assume that the money supply is endogenous in that the usual money multiplier is a function of the interest rate. That is, let the money supply be expressed as

$$(5)\quad M^s = m(i)H, m' > 0,$$

where H denotes the stock of "high-powered," outside money and m(i) denotes the usual money multiplier. Setting (5) equal to (1) results in the equilibrium condition

$$(6)\quad m(i)H = L(i, P(m(i)H)y(i)).$$

Consequently, the effect of an exogenous change in the stock of high-powered money on the interest rate is given by

$$(7)\ di =$$

$$(1 - L_P yP')mdH/(L_i + L_y Py' + (L_P yP' - 1)m'H).$$

The responsiveness of interest rates measured by (7) is strictly smaller than that given by (4) for an identical exogenous change in the money supply, that is, $mdH = dM$.

The Role of Monetary Policy Objectives

There is an exception where it would be appropriate to measure the effect of monetary changes on interest rates in terms of the total money stock despite the presence of inside money. This occurs when the monetary authority is targeting the total money supply and when it is forecasting and quickly offsetting the effect of other factors on the supply of money.[11] For example, suppose that the Federal Reserve is targeting the total money supply but controls only H directly. If m were to rise, say due to a decrease in the public's desire to hold currency relative to checkable deposits, the Fed would attempt to offset the effect of the rise in the money stock by reducing H. If the Fed anticipated the rise in m and changed H by the appropriate amount immediately, there would be no change in the money supply or interest rates associated with the change in H. Estimates of the responsiveness of interest rates to changes in H would be biased downward. If, on the other hand, the Fed does not respond instantaneously, interest rates would be negatively associated with changes in H. In contrast, assume that there is an exogenous increase in the demand for money. If the Fed responds

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[8]The reader should note that there is a somewhat subtle difference between equating the liquidity effect to shifts in the stock of money and shifts in the growth rate of money. The problem here is that the Fisher effect, which relates the *level* of nominal interest rates to the *rate* of inflation, is fundamentally dynamic. The bridge that links these concepts can be found in the monetary growth models where, in long-run equilibrium, both the monetary growth rate and the nominal interest rate are constant. An exogenous increase in the growth rate of money produces a liquidity effect and potentially a Fisher effect. This difference is also reflected in empirical work. For example, compare the approach of Gibson (1970b) with that of Cagan and Gandolfi (1969).

[9]The outcome depends on a number of factors, including the homogeneity of the demand for real money with respect to the price level. If there is no money illusion, the nominal interest rate must rise point for point with the expected rate of inflation. Consequently, if the inflation consequences of an increase in the growth rate of the money stock are fully anticipated, the nominal rate must rise with the acceleration in money growth.

[10]See Patinkin (1965), pp. 297–301, for a good discussion of this point. Of course, this does not apply to exogenous shifts in the stock of inside money, such as a gold discovery under a gold standard.

[11]See Thornton (1984) for a discussion of this point in terms of the issue of debt monetization. Also, see Mishkin (1982) for a discussion of the effects of this form of money stock endogeneity or estimates of the market's response to changes in the money stock.

Also, Mishkin (1981) and Robinson (1988) use M2 to measure the responsiveness of interest rates to changes in the money supply. This is odd since changes in M2 are much more likely to be related to factors other than policy changes.

instantly to offset the effect of this increase on the money stock, interest rates will rise while the money remains unchanged and the stock of high-powered money is reduced. If the Fed does not respond instantaneously, both interest rates and the money stock will initially rise, then interest rates will continue to rise as the money stock falls. The point here is that whether the total money stock or the stock of high-powered money should be used depends on whether the Fed is trying to control the money stock and on how rapidly it is responding to other factors that influence money. This observation has implications for empirical work. If the Fed is attempting to control the total money stock and if the Fed moves reasonably quickly to offset the effect of other factors, measuring the responsiveness of interest rates in terms of the total money supply would be appropriate even if day-to-day or week-to-week shocks were not offset instantaneously.

To determine whether the estimated responsiveness of interest rates is sensitive to the monetary variable used, alternative measures of the monetary impulse are used. This is necessary because the Fed often relies on multiple objectives and is not explicit about them.[12] Of course, if m' is small, the choice of a monetary variable will be relatively unimportant.

Policy-Related Endogeneity

The endogeneity of the money stock discussed above is based upon the economic response of depository institutions and the public to changes in nominal interest rates. Another monetary-policy related view holds that the money supply is endogenous whenever the Fed is using short-term interest rates as an intermediate policy target. In this instance, the Fed merely adjusts the money stock to shifts in the demand for or the supply of money over which it has no control. In the case of exogenous shifts in the money supply function, the Fed neutralizes the effect of such shifts on nominal interest through appropriate open market operations.[13] As a result, both the nominal money stock and the interest rate are unchanged. In the case of shifts in the demand for money, the Fed uses open market operations to accommodate changes in the demand for money. The interest rate remains unchanged, but the money stock changes.

This type of endogeneity creates severe problems for isolating the responsiveness of interest rates to monetary changes because only the market equilibrium values of the interest rate are observed. Since the interest rate is unchanged, despite changes in the money stock, the responsiveness of interest rates to changes in the money stock appears to be nil.[14] If the Fed offsets only part of a demand shift, however, money stock and interest rate changes will be positively correlated. If only part of the exogenous supply shifts are offset, money and interest rates will be negatively correlated. Consequently, statistical analysis may show a positive, negative or no statistically significant relationship between interest rates and money growth, despite the fact that it is precisely because of the liquidity effect that compensatory open market operations are undertaken.

If the Fed reacts instantaneously to these shocks, evidence of the effect of changes in the money stock on interest rates can be obtained with precise knowledge of the Fed's interest rate target. Unfortunately, such information is generally unavailable.[15] Alternatively, a time interval short enough to isolate the response of the market

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[12]For example during most of the 1960s and the early 1970s, the policy directives of the Federal Open Market Committee to the Trading Desk were stated in terms such as "maintain the existing degree of credit restraint." Even when the Fed was targeting the monetary aggregates in the late 1970s and early 1980s, the policy directives often were stated in terms of multiple monetary aggregates and in loose terms, such as "run somewhat above the upper limit of the target range." Moreover, the money growth objectives frequently were conditional on movements of other variables such as the federal funds rate.

[13]The Fed's reaction to offset a supply-side shift is referred to as "defensive open market operations." Stabilizing the normal interest rate will be effective only if the change in the money stock does not give rise to inflationary or deflationary expectations. Proponents of this view would argue this will not happen because the Fed is merely accommodating shifts in the demand for money.

[14]In terms of a more formal model, let H^* be the stock of high-powered money required to hit some target interest rate i^*, i.e., $H^* = L(i^*,Py)/m(i^*)$. From this, $dH/dPy = LPy/m(i)$. The change in the equilibrium interest rate associated with a shift in the demand for money is given by $di/dPy = -[LPy/(L_i - m'H)] + [m(i)/(L_i - m'H)](dH/dPy)$. Substituting in for dH/dPy, yields $di/dPy = 0$.

[15]At times, the Fed's announced ranges for the federal funds rate were fairly narrow. It is difficult to use these ranges to model this relationship, however, because the relationship between the federal funds rate and the T-bill rate, which is usually used to estimate the responsiveness of interest rates to monetary changes, is itself not very stable.

to the Fed's actions could be used. In the absence of such detailed information or such a rich data set, it is important to measure the effect of monetary changes on interest rates during periods in which the Fed was attempting to exert greater control over the money supply.[16]

A REVIEW OF METHODOLOGIES

One method of estimating the responsiveness of interest rates to changes in the money stock, used by Cagan and Gandolfi (1969) and more recently by Melvin (1983) and Brown and Santoni (1983), is to regress the change in the nominal interest rate (Δi_t) on a distributed lag of unanticipated changes in the nominal money stock, ΔM^u. That is, the equation

$$(8)\ \Delta i_t = \alpha_0 + \sum_{i=0}^{K} \beta i\, \Delta M^u_{t-i} + \varepsilon_t$$

is estimated. The random error, ε, is assumed to be identically and independently distributed with a mean of zero and a constant variance, σ^2, that is, ε is iid$(0, \sigma^2)$. This equation is estimated with ordinary least squares (OLS).

A second approach used by Peek (1982), Wilcox (1983a), Mehra (1985), Hoffman and Schlagenhauf (1985) and Peek and Wilcox (1987) employs an IS-LM, aggregate demand/aggregate supply model.[17] In this model, commodity demand is a function of the real interest rate and money demand is a function of the nominal interest rate. While specific models differ, the following specification encompasses the essential features. The IS curve is given by

$$(9)\ y^*_t = a_0 - a_1 r_t + a_2 Z_t + v_{1t}$$

and the LM curve by

$$(10)\ (M_t - P_t) = b_0 + b_1 y^*_t - b_2 i_t + b_3 X_t + v_{2t}.$$

[Unless otherwise stated, all variables are in logarithms.] y^*_t denotes the deviation of real GNP from its "natural rate" (or full employment level), and P and r denote the price level and real interest rate, respectively. Z_t and X_t are vectors of variables that influence the demand for commodities and money, respectively, and v_{1t} and v_{2t} are stochastic disturbances such that v_{1t} is iid$(0, \sigma^2_1)$, v_{2t} is iid$(0, \sigma^2_2)$ and $E(v_{1t}\, v_{2t}) = 0$ for all t. The model is closed by the Phillips curve

$$(11)\ P_t = P^e_t + cy^*_t,$$

where the superscript "e" denotes the expectation based on information known before period t. Equations 9, 10 and 11 are solved for the real interest rate. The result is substituted into the Fisher equation,

$$(12)\ i_t = r_t + \pi^e_t,$$

where π denotes the rate of change in the price level, to yield a quasi-reduced form equation for the nominal interest rate

$$(13)\ i_t = A_0 + A_1 Z_t a_2 + A_2 X_t b_3 - A_3(M_t - P^e_t) + A_4 \pi^e_t + u_t.$$

The responsiveness of the interest rate to real money stock changes, $A_3 = [(c+b_1)a_1 + b_2]^{-1} > 0$, captures not only the "liquidity effect" (b_2), but also the net effect of all other factors that influence the equilibrium interest rate.

While equations 13 and 8 appear quite different, they are both reduced-form equations. The fundamental differences are that equation 13 is stated in *level* rather than first-difference form and that it explicitly includes factors, in addition to the money stock, that could affect nominal interest rates. The absence of these factors from equation 8 could be justified by arguing that it is a final-form equation, not simply a reduced-form equation. On the other hand, estimates of the response of interest rates based on equation 8 could be biased if variation in other factors that affect interest rates is not controlled for.[18]

Another difference is that equation 8 incorporates a distributed lag of unanticipated money, while equation 13 uses only the contemporaneous

[16]It should be noted that Mishkin's (1981, 1982) approach of using unanticipated money does not circumvent this problem. In this instance, unexpected changes in the money stock due to demand and supply shocks are different, so that the coefficient on unexpected money will be different depending on whether the shock emanates from the demand or supply side. Moreover, the effect of an unexpected change in the money supply will be different from the effect of a shock to the money supply.

[17]Actually, this approach was used earlier by Sargent (1969, 1972).

[18]Also, because equation 13 is a quasi-reduced form, the variables Z_t, X_t, P^e_t, M_t or π^e_t may be correlated with the error term. Consequently, OLS estimates of these equations may be inconsistent. Of course, the same would be true of equation 8 if the money stock is endogenous. This observation is the basis for Mehra's (1985) work.

level of actual money. The structure of equations 9–12 can be modified, however, to replace the monetary variable by its unexpected component; a distributed lag of unanticipated money also can be included by appealing to "price-stickiness" or Blinder and Fisher's (1981) inventory adjustment.[19]

A third methodology has roots in the rational expectations/efficient market literature.[20] Mishkin (1981, 1982) and, more recently, Hardouvelis (1986) and Robinson (1988) estimate the equation

$$(14)\ i_t - i^e_t = \alpha_0 + \alpha_1 I_t + \alpha_2(M_t - M^e_t) + \alpha_3(y_t - y^e_t) + \alpha_4(\pi_t - \pi^e_t) + \eta_t.$$

I_t denotes the set of information that market participants have available to them at the beginning of the period, while η_t denotes the error term. Mishkin characterizes equation 14 as the "rational expectations analog of the typical money demand relationship found in the literature."[21]

Mishkin derives equation 14 by using the efficient market/rational expectations model to argue that

$$i_t - i^e_t = (W_t - W^e_t)\beta + \omega_t,$$

where W_t is a vector of variables that reflect the "information relevant to the determination of short-term interest rates" and ω_t denotes the error term.[22] He then solves a monetary equilibrium condition for the interest rate in terms of all the other variables that enter the money demand function, that is, variables which appear as arguments in equation 1. He includes these variables in W_t, arguing that they are part of the relevant information set. Of course, any right-hand-side variable in equation 13 could be considered an element of W_t simply by broadening the theoretical framework. Consequently, equation 14 differs from the other specifications primarily in its explicit and complete reliance on the efficient markets/rational expectations paradigm.

Furthermore, equations 8, 13 and 14 are alternative representations for the nominal interest rate. Thus, they can be compared directly using standard nested and/or nonnested test procedures.

EMPIRICAL ESTIMATES OF THE LIQUIDITY EFFECT

The empirical estimates presented here cover the period from 1958.08 to 1987.06. Prior studies have generally used quarterly data when estimating equations 13 and 14 and monthly data when estimating equation 8. This study uses monthly observations for all specifications. The month period is short enough that the liquidity effect is less likely to be weakened by subsequent income, price level or inflation-expectations effects. On the other hand, many of the variables that might reasonably enter equations like 13 are unavailable on a monthly basis, so that the estimates are subject to a potential omitted-variables bias.

The variables used are

y = the real value of the industrial production index,

TBR = the three-month Treasury bill rate,

P = the CPI,

M = the M1 definition of the money stock,

MB = the Federal Reserve Bank of St. Louis adjusted monetary base,

and

NBR = the Federal Reserve Bank of St. Louis adjusted nonborrowed reserves.

Two measures of unanticipated changes in the money supply are used here. The first is the change in the growth rate of money. Cagan and Gandolfi use changes in the growth rate of money to proxy such changes, arguing that the market should respond only to unanticipated changes in the money stock.[23] Today, the unanticipated change

[19]For example, see Makin (1983) and Hoffman and Schlagenhauf (1985).

[20]Dwyer (1981) has an alternative rational expectations framework where, because the same factors affect both the expected inflation rate and the real interest rate, they give rise to a set of cross-equation restrictions that can be tested.

[21]Mishkin (1982), p. 66.

[22]Mishkin (1982), p. 64.

[23]Cagan and Gandolfi (1969) p. 279, state "It is hard to determine to what extent monetary changes at any particular time are anticipated, but presumably a steady growth rate will sooner or later come to be reflected in a corresponding rise in prices (allowing for the growth rate of real income). Consequently, changes in the monetary growth rate will tend to produce, every time they occur, a response in interest rates . . ." Gibson (1970a) uses a similar equation based on an analogous argument; however, Gibson (1970b) regresses first differences of the interest rate on first differences of the money stock.

in the growth rate of money typically would be obtained by subtracting expected money growth, estimated using some time-series method, from actual money growth. Nevertheless, because Cagan and Gandolfi's procedure has been utilized by all who have estimated equation 8, their measure of unanticipated money is used to see if the results are sensitive to the form of the unanticipated monetary variable.

Additionally, unanticipated money is measured by $(\Delta M\text{-}\Delta M^e)$, where ΔM^e is a time-series representation of past ΔM. In this instance, the expected values of M, y and P are obtained by regressing each on a six-month distributed lag of itself and the other variables, including changes in the Treasury bill rate.[24]

This study uses three monetary policy variables: M1, the adjusted monetary base (MB), and nonborrowed reserves (NBR). The monetary base is used often as a measure of exogenous monetary policy. NBR is used because some would argue that it is a better measure of the exogenous monetary impulse than MB because depository institutions' borrowings from the Federal Reserve are related to the interest rate. Also, the Fed used a NBR-operating procedure to control the money stock from October 1979 to October 1982. Since the Fed was primarily targeting M1 growth during this period, however, unanticipated M1 growth may be a better measure of the exogenous monetary impulse during this period.

Alternative measures of the monetary impulse are used to see whether estimates of the responsiveness of interest rates to monetary impulses are dependent on the variable used.

Initially, the equation

$$(15)\ \Delta TBR_t = \alpha_0 + \sum_{i=1}^{6} \alpha_i \Delta TBR_{t-i} + \beta MV_t^u + \mu PV_t^u + \delta yV_t^u + \varepsilon_t$$

is estimated. The unanticipated monetary variable, MV^u, is alternately proxied by $\Delta\dot{M}1$, $\Delta\dot{M}B$, $\Delta N\dot{B}R$, $(\Delta M1\text{-}\Delta M1^e)$, $(\Delta MB - \Delta MB^e)$ and $(\Delta NBR - \Delta NBR^e)$.[25] The unanticipated price (PV^u) and income (yV^u) variables are alternatively measured by $\Delta\dot{P}$ and $\Delta\dot{y}$ or $(\Delta P - \Delta P^e)$ and $(\Delta y - \Delta y^e)$.[26] This specification, and others which follow, include a finite distributed lag of the dependent variable to capture any effect of past information.[27]

OLS estimates of equation 15 for the period 1959.08–1987.06 and two subperiods, 1959.08–1973.09 and 1973.10–1987.06, are presented in tables 1–3. The split was made at 1973.09 because (1) it marks the well-known break in the demand for money, (2) it roughly coincides with the demise of the Bretton Woods agreement and (3) it also roughly coincides with the beginning of an era in which the Federal Reserve claimed to pay increasing attention to the growth rate of the monetary aggregates.[28] The equation is estimated with and without PV^u and yV^u to determine how sensitive the results are to these variables.

The results indicate considerable variability in the statistical significance of the effect of the monetary variables on interest rates, both across time and across monetary variables. During the entire period, there is a small but statistically significant negative effect for three of the unanticipated monetary variables. The largest statistically significant negative effect is obtained when $\Delta\dot{M}1$ is used, but there is a statistically significant negative response of interest rates when the unanticipated growth of nonborrowed reserves is used, whether it is measured by $\Delta N\dot{B}R$ or $(\Delta NBR - \Delta NBR^e)$.

The results in tables 2 and 3 indicate that the responsiveness of interest rates to monetary impulses is sensitive to the sample period. When pre-1974 data are used (table 2) the effect is statistically significant only when the unanticipated change in the growth rate of nonborrowed re-

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[24]This is similar to the multivariate time-series approach of Mishkin (1981) except that a distributed lag of the ΔTBR is included in all regressions. It is important to include all relevant variables that affect interest rates. Wickens (1982) has argued that if they are not included, the expectations cannot be efficient.

Also, there was some experimentation with alternative lag lengths. The lags used here appeared to work well and produced white noise residuals.

[25]When $(\Delta M - \Delta M^e)$ is used, ΔM denotes the annualized first difference of the log of the variable. $\Delta\dot{M}$, however, is the first difference of the annualized growth rate of the variable. The same is true for all other variables.

[26]The unanticipated monetary, price and income variables are matched in the regressions. That is, if $\Delta\dot{M}1$ is used as the monetary variable, then $\Delta\dot{P}$ and $\Delta\dot{y}$ are used as the corresponding unanticipated price and income variables.

[27]The coefficients on the lagged dependent variable are not reported. In nearly every instance, they were jointly significant at the 5 percent level.

[28]Hafer and Hein (1982) date the break in money demand at 1973.04, while Lin and Oh (1984) date it at 1972.02. The United States formally broke from the Bretton Woods accord in late 1971.

The Federal Reserve Open Market Committee stated a desire to place increased emphasis on the growth of certain monetary aggregates at its January 15, 1970 meeting; Congress passed Resolution 133 requiring the Board of Governors to set long-run ranges for the aggregates on March 24, 1975.

Table 1
Estimates of Equation 15: 1959.08 – 1987.06

MV^u	Constant	MV^u	$yV^{u\,1}$	$PV^{u\,1}$	$\bar{R}^2$	SEE
$\Delta\dot{M}1$	.008	–.015*	.003	.014*	.254	.5089
	(0.28)	(3.68)	(1.25)	(1.71)		
	.008	–.016*	—	—	.250	.5103
	(0.30)	(3.79)				
$\Delta\dot{M}B$	.008	–.000	.003	.016*	.223	.5194
	(0.29)	(0.05)	(1.37)	(1.85)		
	.009	–.000	—	—	.217	.5214
	(0.30)	(0.06)				
$\Delta N\dot{B}R$	.008	–.005*	.003	.011	.251	.5099
	(0.28)	(3.49)	(1.31)	(1.31)		
	.008	–.004*	—	—	.249	.5107
	(0.29)	(3.74)				
$(\Delta M1 - \Delta M1^e)$	.009	–.007	.008*	.029*	.242	.5129
	(0.31)	(1.23)	(2.88)	(2.46)		
	.009	–.006	—	—	.219	.5206
	(0.31)	(1.04)				
$(\Delta MB - \Delta MB^e)$	.009	.014	.009*	.040*	.260	.5069
	(0.31)	(1.51)	(3.16)	(3.36)		
	.009	.017	—	—	.225	.5186
	(0.31)	(1.89)				
$(\Delta NBR - \Delta NBR^e)$	.009	–.009*	.008*	.033*	.320	.4860
	(0.33)	(5.41)	(2.94)	(3.00)		
	.009	–.010*	—	—	.293	.4954
	(0.32)	(5.94)				

[1]Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.
* Indicates statistical significance at the 5 percent level.

serves is measured by $(\Delta NBR - \Delta NBR^e)$ and when PV^u and yV^u are omitted. Even in this case, however, the strength of the effect is small.

In contrast, there is a statistically significant negative effect during the latter period (table 3) when $\Delta\dot{M}1$ or NBR, in either form, is the monetary variable. These results are interesting because they suggest that the response of interest rates is stronger during the latter period, when the Fed claims to have paid more attention to monetary aggregates and when Melvin (1983) reports that the effect vanishes. Finally, the coefficient for unanticipated base growth measured by $(\Delta MB - \Delta MB^e)$, is significantly positive during this period.

Both quantitatively and qualitatively, the results are similar whether the unanticipated price or income variables are included. Accounting for the possible effect of unanticipated inflation or income growth does not appear to be important in measuring the effect of unanticipated monetary growth on interest rates.[29] The effects of unanticipated inflation and income growth are highly significant for the entire period, but they are much less so during the individual subperiods.[30]

[29]This result is not too surprising in the case where the unanticipated variables are measured by the difference between actual and expected. It is usually assumed, either explicitly or implicitly, that in the case where the expectation-generating equations are jointly estimated with the "structural" equation, the unanticipated components are mutually orthogonal. (Estimates indicate that this condition is reasonably satisfied for the specifications used here). When these variables are measured in this way, the regressors of equation 15 are nearly mutually orthogonal. Consequently, the parameter estimates of one are not likely to be affected by the absence of the others.

[30]This could be a manifestation of the heteroskedasticity in the data. In general, heteroskedasticity may cause the reported standard errors of the parameters of OLS to be biased, and they can be either too large or too small.

Table 2

Estimates of Equation 15: 1959.08 – 1973.09

MV^u	Constant	MV^u	yV^u[1]	PV^u[1]	$\bar{R}^2$	SEE
$\Delta\dot{M}1$	.017	.001	.001	.007	.160	.2544
	(0.86)	(0.32)	(0.56)	(1.28)		
	.017	.001	—	—	.162	.2542
	(0.88)	(0.16)				
$\Delta\dot{M}B$	.017	.000	.001	.007	.160	.2545
	(0.87)	(0.10)	(0.54)	(1.21)		
	.017	−.001	—	—	.162	.2541
	(0.88)	(0.30)				
$\Delta N\dot{B}R$	.017	−.000	.001	.007	.160	.2544
	(0.87)	(0.21)	(0.54)	(1.19)		
	.017	−.000	—	—	.162	.2541
	(0.88)	(0.42)				
$(\Delta M1 - \Delta M1^e)$	.017	.006	.001	.017	.172	.2527
	(0.89)	(1.10)	(0.37)	(1.66)		
	.017	.006	—	—	.168	.2533
	(0.88)	(1.11)				
$(\Delta MB - \Delta MB^e)$	.017	.001	.002	.013	.161	.2543
	(0.88)	(0.20)	(0.82)	(1.28)		
	.017	.002	—	—	.162	.2542
	(0.88)	(0.25)				
$(\Delta NBR - \Delta NBR^e)$	.017	−.003	.002	.022*	.198	.2487
	(0.90)	(1.82)	(1.07)	(2.20)		
	.017	−.004*	—	—	.182	.2511
	(0.89)	(2.02)				

[1]Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.
* Indicates statistical significance at the 5 percent level.

Because the results could be specific to the form of equation 15, the equation

$$(16)\quad \Delta TBR_t = \alpha_0 + \sum_{i=1}^{6} \alpha_i \Delta TBR_{t-i} + \sum_{i=0}^{36} \beta_i MV^u_{t-i} + \varepsilon_t,$$

was estimated using the same data for the same periods.[31] These results, reported in tables 4–6, are strikingly different from those in tables 1–3. For the entire period (table 4) there is no statistically significant, negative response of interest rates, even initially, when $\Delta\dot{M}1$ or $\Delta\dot{M}B$ is used. Moreover, the sum of the coefficients is significantly positive for both monetary variables. These results are consistent with those reported by Cagan and Gandolfi (1969), Brown and Santoni (1983) and Melvin (1983). When $\Delta N\dot{B}R$ is used, however, there is a significant initial negative response of interest rates for the entire period, and the sum of the coefficients is negative and significant.

The results using the unanticipated monetary variable measured by $(\Delta MV - \Delta MV^e)$ are considerably different from those using $\Delta\dot{M}V$.[32] For both M1 and MB, few coefficients are significant and most of these are positive. Also, while the sums of the coefficients are positive, they are not statistically significant. When NBR is used, the initial coefficient is negative and significant, but the sum of the coefficients is positive and not significant.

Most of the results for the pre-1974 period (table 5) are qualitatively the same as those for the entire period. One exception is for $(\Delta NBR - \Delta NBR^e)$, when the initial coefficient is negative but not significant

[31]Cagan and Gandolfi (1969) used 38 lags, Melvin (1983) used 36 and Brown and Santoni (1983) used 24. Because of the long lags involved, it was necessary to delete the first three years from the entire estimation period and from the first subperiod when $(\Delta MV - \Delta MV^e)$ is used as the monetary variable.

[32]OLS estimates of the standard errors of the coefficients are biased downward when unanticipated monetary variables are measured by $(\Delta MV - \Delta MV^e)$. Consequently, the reported t-ratios overstate the significance of the effect of unanticipated monetary impulses. See Pagan (1984) p. 234.

Table 3

Estimates of Equation 15: 1973.10 – 1987.06

MV^u	Constant	MV^u	yV^u[1]	PV^u[1]	$\bar{R}^2$	SEE
$\Delta\dot{M}1$	−.015	−.022*	.006	.027	.282	.6708
	(0.30)	(3.44)	(1.17)	(1.65)		
	−.016	−.022*	—	—	.274	.6745
	(0.30)	(3.45)				
$\Delta\dot{M}B$	−.013	−.002	.006	.028	.227	.6958
	(0.25)	(0.16)	(1.21)	(1.82)		
	−.014	−.000	—	—	.219	.6996
	(0.26)	(0.03)				
$\Delta N\dot{B}R$	−.014	−.006*	.005	.020	.269	.6766
	(0.26)	(2.99)	(0.91)	(1.22)		
	−.014	−.007*	—	—	.269	.6767
	(0.27)	(3.29)				
$(\Delta M1 - \Delta M1^e)$	−.014	−.013	.011*	.044*	.244	.6882
	(0.26)	(1.31)	(1.78)	(1.99)		
	−.014	−.010	—	—	.224	.6973
	(0.26)	(1.01)				
$(\Delta MB - \Delta MB^e)$	−.014	.030	.012*	.044*	.261	.6805
	(0.26)	(1.68)	(1.92)	(1.97)		
	−.014	.037*	—	—	.240	.6903
	(0.26)	(2.07)				
$(\Delta NBR - \Delta NBR^e)$	−.014	−.010*	.009	.045*	.314	.6556
	(0.27)	(3.53)	(1.50)	(2.16)		
	.014	−.012*	—	—	.296	.6641
	(0.27)	(4.15)				

[1] Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.

* Indicates statistical significance at the 5 percent level.

and the sum of the coefficients is positive and significant.

The results for the post-1973 period (table 6) are different when NBR is used. The initial negative response of interest rates is larger during the post-1973 period and is statistically significant regardless of how unanticipated nonborrowed reserves are measured. The sums of the coefficients, however, are not significantly different from zero. Thus, while the magnitude of the negative effect is larger during this period, it is not permanent. The results for the M1 and MB measures are similar to those of the entire period.

Tests of Alternative Specifications

Tables 1–6 show that the results are sensitive to the specification of the monetary variable and to the sample period. Consequently, it is important to test which monetary variable, if any, best explains changes in the interest rate. To this end, the specifications with alternative monetary variables are tested against one another using the Davidson and MacKinnon (1981) J-test. In order for the test to favor specification A over specification B conclusively, the information in B must not be significant when specification A is the null hypothesis and the information in specification A must be significant when B is the null.

Table 7 presents the test results which, though largely inconclusive, favor M1 and NBR when unexpected money is specified in $\Delta\dot{M}V$ form. This is due solely to the post-1973 period, however. When the monetary variables are specified in $(\Delta MV - \Delta MV^e)$ form, the results tend to favor NBR.[33]

[33] Although not reported here, the results of the J-test applied to the specification given by equation 16 were also inconclusive.

Table 4

Estimates of Equation 16: 1962.08 − 1987.06

Lag	$\Delta\dot{M}1$	$\Delta M1-\Delta M1^e$	$\Delta\dot{M}B$	$\Delta MB-\Delta MB^e$	$\Delta\dot{N}BR$	$\Delta NBR-\Delta NBR^e$	Lag	$\Delta\dot{M}1$	$\Delta M1-\Delta M1^e$	$\Delta\dot{M}B$	$\Delta MB-\Delta MB^e$	$\Delta\dot{N}BR$	$\Delta NBR-\Delta NBR^e$
Constant	−0.033	−0.006	−.028	−.009	.033	.027	20	0.037*	−0.008	0.065*	−0.003	−0.008	0.001
	(1.09)	(0.19)	(0.85)	(0.28)	(1.05)	(0.81)		(2.86)	(1.18)	(3.04)	(0.28)	(1.79)	(0.48)
0	−0.003	−0.005	0.021*	0.019	−0.010*	−0.011*	21	0.032*	−0.012	0.059*	−0.002	−0.009	−0.000
	(0.47)	(0.80)	(2.01)	(1.65)	(5.73)	(5.56)		(2.53)	(1.74)	(2.76)	(0.14)	(1.93)	(0.15)
1	0.037*	0.039*	0.052*	0.033*	−0.009*	−0.002	22	0.040*	0.002	0.066*	0.011	−0.010*	−0.002
	(5.08)	(6.24)	(3.48)	(2.87)	(4.28)	(0.80)		(3.13)	(0.23)	(3.09)	(1.03)	(2.18)	(0.86)
2	0.033*	0.003	0.059*	0.009	−0.006*	0.003	23	0.041*	0.004	0.060*	0.004	−0.009*	−0.000
	(3.66)	(0.43)	(3.19)	(0.75)	(2.47)	(1.57)		(3.18)	(0.57)	(2.77)	(0.36)	(2.02)	(0.11)
3	0.042*	0.005	0.058*	0.000	−0.008*	0.001	24	0.031*	−0.006	0.053*	0.008	−0.011*	−0.001
	(4.32)	(0.75)	(2.77)	(0.01)	(2.88)	(0.26)		(2.39)	(0.86)	(2.48)	(0.69)	(2.33)	(0.40)
4	0.030*	−0.002	0.039	−0.012	−0.007*	0.001	25	0.027*	−0.001	0.053*	0.012	−0.007	0.004*
	(2.81)	(0.25)	(1.77)	(1.03)	(2.48)	(0.67)		(2.12)	(0.09)	(2.47)	(1.04)	(1.50)	(2.05)
5	0.033*	0.001	0.051*	0.026*	−0.011*	−0.003	26	0.026*	−0.006	0.048*	−0.006	−0.008	−0.000
	(3.01)	(0.08)	(2.26)	(2.20)	(3.29)	(1.22)		(2.08)	(0.80)	(2.23)	(0.49)	(1.74)	(0.15)
6	0.034*	0.016*	0.051*	0.021	−0.011*	−0.000	27	0.023	−0.008	0.034	−0.017	−0.009*	−0.002
	(3.04)	(2.25)	(2.33)	(1.81)	(2.97)	(0.09)		(1.89)	(1.08)	(1.61)	(1.53)	(2.17)	(0.72)
7	0.032*	0.010	0.044*	−0.003	−0.011*	−0.001	28	0.023	−0.001	0.036	0.001	−0.009*	−0.000
	(2.96)	(1.38)	(2.07)	(0.29)	(2.98)	(0.47)		(1.92)	(0.19)	(1.71)	(0.12)	(2.15)	(0.09)
8	0.033*	0.009	0.031	−0.002	−0.011*	0.003	29	0.024*	−0.002	0.041*	0.004	−0.009*	−0.000
	(2.90)	(1.24)	(1.43)	(0.21)	(2.69)	(1.54)		(2.10)	(0.33)	(2.00)	(0.37)	(2.29)	(0.16)
9	0.033*	0.007	0.036	0.010	−0.010*	0.001	30	0.025*	−0.006	0.031	−0.012	−0.006	0.003
	(2.93)	(1.07)	(1.68)	(0.81)	(2.38)	(0.35)		(2.36)	(0.88)	(1.57)	(1.08)	(1.72)	(1.48)
10	0.036*	0.004	0.047*	0.02	−0.011*	−0.001	31	0.022*	−0.005	0.034	0.005	−0.006	0.001
	(3.06)	(0.51)	(2.19)	(1.31)	(2.63)	(0.33)		(2.16)	(0.65)	(1.76)	(0.50)	(1.57)	(0.57)
11	0.046*	0.012	0.047*	0.007	−0.011*	−0.001	32	0.024*	0.004	0.020	−0.006	−0.006	−0.000
	(3.83)	(1.72)	(2.22)	(0.58)	(2.58)	(0.39)		(2.40)	(0.53)	(1.13)	(0.51)	(1.83)	(0.02)
12	0.042*	−0.002	0.055*	0.014	−0.007	0.005*	33	0.014	−0.004	0.022	−0.005	−0.005	−0.000
	(3.37)	(0.32)	(2.61)	(1.16)	(1.64)	(2.31)		(1.60)	(0.53)	(1.30)	(0.46)	(1.69)	(0.21)
13	0.023	−0.020*	0.040	0.002	−0.009*	0.000	34	0.021*	0.007	0.017	0.000	−0.001	0.004
	(1.83)	(2.92)	(1.90)	(0.14)	(2.02)	(0.14)		(2.62)	(0.99)	(1.12)	(0.02)	(0.49)	(1.88)
14	0.027*	0.000	0.054*	0.023*	−0.010*	−0.002	35	0.009	−0.005	0.019	0.004	0.002	0.003
	(2.18)	(0.01)	(2.54)	(1.98)	(2.06)	(0.98)		(1.30)	(0.73)	(1.54)	(0.37)	(0.62)	(1.35)
15	0.032*	0.009	0.045*	0.007	−0.009	0.001	36	0.015*	0.010	0.013	−0.013	0.000	−0.000
	(2.60)	(1.23)	(2.13)	(0.60)	(1.90)	(0.36)		(2.59)	(1.48)	(1.37)	(1.21)	(0.25)	(0.17)
16	0.021	−0.014	0.049*	0.008	−0.009	−0.002							
	(1.64)	(1.97)	(2.31)	(0.69)	(1.92)	(0.86)	Sum of						
17	0.028*	0.009	0.058*	0.003	−0.010*	−0.001	Lags	1.075*	.043	1.645*	.181	−0.304*	.001
	(2.27)	(1.18)	(2.76)	(0.28)	(2.03)	(0.68)		(3.76)	(0.94)	(3.30)	(1.89)	(2.77)	(0.09)
18	0.039*	0.004	0.064*	0.007	−0.011*	−0.002							
	(3.11)	(0.57)	(3.07)	(0.60)	(2.37)	(0.84)	$F^†$	2.82*	2.39*	1.22	0.99	1.65*	1.65*
19	0.045*	−0.003	0.072*	0.009	−0.010*	−0.000	$\bar{R}^2$	.37	.34	.24	.22	.28	.28
	(3.55)	(0.44)	(3.43)	(0.78)	(2.07)	(0.06)	SEE	.4912	.5025	.5374	.5453	.5237	.5237

*Indicates statistical significance at the 5 percent level.

†F-statistic for the joint significance of the monetary variables.

Table 5

Estimates of Equation 16: 1962.08 – 1973.09

Lag	$\Delta\dot{M}1$	$\Delta M1 - \Delta M1^e$	$\Delta\dot{MB}$	$\Delta MB - \Delta MB^e$	$\Delta\dot{NBR}$	$\Delta NBR - \Delta NBR^e$
Constant	–.024	.010	–.006	.010	.032	.041
	(1.03)	(0.47)	(0.23)	(0.43)	(1.48)	(1.93)
0	0.011	0.012	–0.007	–0.011	–0.004*	–0.003
	(1.72)	(1.74)	(0.84)	(1.23)	(2.33)	(1.46)
1	0.003	–0.001	–0.007	0.003	–0.008*	–0.001
	(0.38)	(0.15)	(0.58)	(0.37)	(2.70)	(0.57)
2	0.004	–0.002	–0.005	0.001	–0.009*	–0.000
	(0.39)	(0.36)	(0.38)	(0.08)	(2.37)	(0.02)
3	0.004	–0.006	–0.025	–0.022*	–0.011*	–0.002
	(0.43)	(0.81)	(1.66)	(2.38)	(2.60)	(0.98)
4	0.009	0.002	–0.009	0.012	–0.010*	0.002
	(0.81)	0.23	(0.57)	(1.26)	(2.10)	(0.99)
5	0.009	–0.004	0.003	0.012	–0.012*	–0.000
	(0.79)	(0.58)	(0.19)	(1.27)	(2.42)	(0.12)
6	0.016	0.012	0.012	0.010	–0.012*	0.002
	(1.50)	(1.67)	(0.71)	(1.10)	(2.27)	(1.11)
7	0.026*	0.019*	0.021	0.015	–0.013*	0.002
	(2.35)	(2.70)	(1.23)	(1.69)	(2.48)	(1.15)
8	0.031*	0.007	0.022	0.006	–0.012*	0.005*
	(2.62)	(1.01)	(1.29)	(0.67)	(2.13)	(2.39)
9	0.036*	0.007	0.019	0.004	–0.011	0.004
	(2.92)	(0.88)	(1.14)	(0.43)	(1.95)	(1.86)
10	0.048*	0.012	0.025	0.014	–0.013*	–0.000
	(3.78)	(1.64)	(1.49)	(1.56)	(2.21)	(0.04)
11	0.053*	0.006	0.017	0.001	–0.015*	–0.000
	(4.12)	(0.74)	(1.03)	(0.12)	(2.58)	(0.16)
12	0.041*	–0.008	0.023	0.003	–0.013*	0.004*
	(3.12)	(1.08)	(1.40)	(0.36)	(2.15)	(2.15)
13	0.035*	–0.002	0.009	–0.013	–0.011	0.004*
	(2.68)	(0.30)	(0.53)	(1.31)	(1.80)	(2.15)
14	0.023	–0.006	0.012	0.006	–0.010	0.003
	(1.77)	(0.72)	(0.72)	(0.59)	(1.70)	(1.21)
15	0.025	0.002	0.012	0.010	–0.008	0.003
	(1.93)	(0.23)	(0.70)	(1.10)	(1.51)	(1.57)
16	0.018	–0.009	0.010	–0.003	–0.011*	–0.000
	(1.38)	(1.27)	(0.56)	(0.29)	(2.14)	(0.12)
17	0.030*	0.005	0.021	0.010	–0.011*	0.003
	(2.21)	(0.68)	(1.24)	(1.12)	(2.24)	(1.29)
18	0.045*	0.018*	0.016	0.003	–0.010*	0.006*
	(3.39)	(2.57)	(0.92)	(0.32)	(1.96)	(2.76)
19	0.046*	0.001	0.021	0.014	–0.007	0.004*
	(3.41)	(0.12)	(1.21)	(1.56)	(1.47)	(2.02)

Lag	$\Delta\dot{M}1$	$\Delta M1 - \Delta M1^e$	$\Delta\dot{MB}$	$\Delta MB - \Delta MB^e$	$\Delta\dot{NBR}$	$\Delta NBR - \Delta NBR^e$
20	0.038*	–0.008	0.007	–0.009	–0.010*	–0.002
	(2.83)	(1.15)	(0.40)	(1.15)	(2.05)	(0.86)
21	0.034*	–0.004	0.017	0.011	–0.011*	0.001
	(2.57)	(0.58)	(1.00)	(1.39)	(2.15)	(0.40)
22	0.038*	0.005	0.027	0.011	–0.008	0.005*
	(2.94)	(0.65)	(1.62)	(1.35)	(1.61)	(2.48)
23	0.041*	–0.003	0.040*	0.011	–0.005	0.006*
	(3.15)	(0.40)	(2.45)	(1.29)	(0.93)	(2.88)
24	0.040*	–0.007	0.029	–0.011	–0.007	–0.002
	(3.09)	(0.91)	(1.72)	(1.30)	(1.34)	(1.06)
25	0.043*	0.004	0.025	0.002	–0.005	0.002
	(3.40)	(0.60)	(1.56)	(0.22)	(1.05)	(0.67)
26	0.037*	–0.004	0.022	–0.002	–0.006	0.001
	(2.99)	(0.52)	(1.34)	(0.18)	(1.20)	(0.61)
27	0.025*	–0.012	0.009	–0.010	–0.003	0.005*
	(2.05)	(1.63)	(0.54)	(1.20)	(0.67)	(2.08)
28	0.029*	0.004	0.015	0.006	–0.004	–0.000
	(2.43)	(0.48)	(0.95)	(0.77)	(1.03)	(0.21)
29	0.028*	0.000	0.027	0.013	–0.002	0.003
	(2.49)	(0.02)	(1.84)	(1.62)	(0.50)	(1.38)
30	0.034*	0.003	0.028	–0.002	–0.005	0.001
	(3.11)	(0.45)	(1.94)	(0.21)	(1.13)	(0.53)
31	0.021	–0.012	0.028	0.001	–0.004	0.000
	(1.95)	(1.59)	(1.97)	(0.14)	(1.11)	(0.13)
32	0.031*	0.010	0.014	–0.007	–0.005	0.001
	(2.86)	(1.31)	(1.02)	(0.80)	(1.25)	(0.45)
33	0.027*	–0.002	0.023	0.014	–0.000	0.005*
	(2.61)	(0.27)	(1.84)	(1.72)	(0.11)	(2.33)
34	0.041*	0.008	0.038*	0.022*	0.002	0.003
	(4.15)	(1.11)	(3.20)	(2.60)	(0.48)	(1.29)
35	0.030*	–0.011	0.026*	–0.009	0.002	0.001
	(3.53)	(1.56)	(2.53)	(1.05)	(0.61)	(0.31)
36	0.030*	0.014	0.015	–0.009	0.005*	0.006*
	(4.80)	(1.84)	(1.93)	(0.99)	(2.28)	(2.42)
Sum of Lags	1.078*	.049	0.582	.110	–.278*	.071*
	(3.62)	(0.77)	(1.48)	(1.17)	(2.06)	(3.12)
F[1]	1.88*	1.38	1.62*	1.49	1.65*	1.97*
$\bar{R}^2$	.35	.27	.31	.29	.32	.37
SEE	.2288	.2435	.2362	.2400	.2351	.2265

*Indicates statistical significance at the 5 percent level.

[1]F – statistic for the joint significance of the monetary variables.

Table 6

Estimates of Equation 16: 1973.10 – 1987.06

Lag	$\Delta\dot{M}1$	$\Delta M1-\Delta M1^e$	$\Delta\dot{M}B$	$\Delta MB-\Delta MB^e$	$\Delta\dot{N}BR$	$\Delta NBR-\Delta NBR^e$
Constant	−.046	−.058	−.028	.001	.020	−.029
	(0.92)	(0.94)	(0.52)	(0.01)	(0.36)	(0.40)
0	−0.008	−0.002	0.039*	0.049	−0.013*	−0.013*
	(0.99)	(0.20)	(2.18)	(1.97)	(4.65)	(3.28)
1	0.050*	0.062*	0.094*	0.029	−0.010*	−0.000
	(4.58)	(5.44)	(3.69)	(1.11)	(3.04)	(0.06)
2	0.044*	−0.005	0.100*	−0.002	−0.005	0.004
	(3.17)	(0.40)	(3.02)	(0.09)	(1.43)	(1.09)
3	0.055*	0.020	0.111*	0.030	−0.008	0.004
	(3.65)	(1.53)	(2.92)	(1.14)	(1.97)	(1.02)
4	0.039*	0.000	0.070	−0.052	−0.007	0.002
	(2.37)	(0.01)	(1.73)	(1.93)	(1.53)	(0.37)
5	0.045*	0.008	0.082*	0.085*	−0.011*	−0.002
	(2.58)	(0.58)	(2.01)	(3.11)	(2.25)	(0.55)
6	0.042*	0.024	0.076	0.020	−0.011*	0.001
	(2.33)	(1.75)	(1.94)	(0.66)	(2.04)	(0.28)
7	0.032	0.006	0.060	−0.033	−0.010	0.000
	(1.94)	(0.39)	(1.60)	(1.11)	(1.72)	(0.02)
8	0.030	0.016	0.032	−0.006	−0.010	0.002
	(1.82)	(1.15)	(0.86)	(0.21)	(1.62)	(0.59)
9	0.031	−0.001	0.033	0.028	−0.009	−0.002
	(1.84)	(0.10)	(0.89)	(1.05)	(1.43)	(0.58)
10	0.026	0.002	0.040	−0.005	−0.011	−0.002
	(1.54)	(0.17)	(1.08)	(0.20)	(1.65)	(0.46)
11	0.041*	0.014	0.047	0.014	−0.010	−0.000
	(2.33)	(1.05)	(1.28)	(0.55)	(1.49)	(0.10)
12	0.040*	−0.003	0.056	0.030	−0.005	0.005
	(2.20)	(0.21)	(1.55)	(1.17)	(0.74)	(1.26)
13	0.013	−0.034*	0.034	−0.014	−0.008	−0.002
	(0.71)	(2.55)	(0.96)	(0.56)	(1.20)	(0.42)
14	0.020	0.005	0.053	0.056*	−0.008	−0.004
	(1.11)	(0.34)	(1.50)	(2.25)	(1.15)	(1.05)
15	0.028	0.012	0.043	0.026	−0.008	−0.001
	(1.57)	(0.82)	(1.21)	(1.00)	(1.13)	(0.38)
16	0.013	−0.014	0.059	0.021	−0.008	−0.000
	(0.71)	(0.98)	(1.69)	(0.83)	(1.08)	(0.11)
17	0.022	0.020	0.066	−0.012	−0.007	−0.003
	(1.22)	(1.39)	(1.94)	(0.48)	(0.94)	(0.70)
18	0.036*	0.002	0.082*	0.041	−0.011	−0.007
	(2.00)	(0.14)	(2.42)	(1.66)	(1.48)	(1.77)
19	0.044*	0.008	0.091*	0.001	−0.009	−0.002
	(2.44)	(0.57)	(2.68)	(0.04)	(1.27)	(0.42)

Lag	$\Delta\dot{M}1$	$\Delta M1-\Delta M1^e$	$\Delta\dot{M}B$	$\Delta MB-\Delta MB^e$	$\Delta\dot{N}BR$	$\Delta NBR-\Delta NBR^e$
20	0.032	−0.018	0.093*	0.003	−0.006	0.002
	(1.73)	(1.29)	(2.68)	(0.12)	(0.80)	(0.50)
21	0.031	−0.013	0.086*	0.007	−0.009	−0.003
	(1.65)	(0.96)	(2.43)	(0.29)	(1.25)	(0.86)
22	0.044*	0.000	0.101*	0.013	−0.010	−0.003
	(2.37)	(0.01)	(2.84)	(0.54)	(1.30)	(0.67)
23	0.039*	0.003	0.077*	−0.011	−0.009	−0.006
	(2.08)	(0.22)	(2.12)	(0.49)	(1.27)	(1.49)
24	0.026	−0.009	0.069	0.022	−0.011	−0.003
	(1.35)	(0.65)	(1.88)	(0.94)	(1.49)	(0.88)
25	0.022	0.003	0.067	0.032	−0.006	0.008
	(1.18)	(0.22)	(1.81)	(1.40)	(0.86)	(1.93)
26	0.018	−0.011	0.059	−0.032	−0.008	−0.005
	(0.99)	(0.79)	(1.57)	(1.37)	(1.15)	(1.19)
27	0.012	−0.003	0.046	−0.008	−0.011	−0.005
	(0.69)	(0.20)	(1.21)	(0.36)	(1.60)	(1.17)
28	0.014	−0.001	0.041	−0.018	−0.009	−0.002
	(0.78)	(0.08)	(1.06)	(0.78)	(1.44)	(0.42)
29	0.016	0.003	0.037	−0.001	−0.010	−0.002
	(0.93)	(0.19)	(0.97)	(0.03)	(1.55)	(0.55)
30	0.015	−0.011	0.024	−0.020	−0.007	−0.003
	(0.90)	(0.87)	(0.66)	(0.87)	(1.20)	(0.62)
31	0.014	−0.002	0.028	0.022	−0.007	0.003
	(0.92)	(0.17)	(0.81)	(0.94)	(1.23)	(0.66)
32	0.018	0.012	0.013	−0.001	−0.007	−0.001
	(1.19)	(0.94)	(0.41)	(0.06)	(1.29)	(0.32)
33	0.009	0.000	0.014	−0.007	−0.007	−0.003
	(0.70)	(0.00)	(0.49)	(0.31)	(1.47)	(0.74)
34	0.015	0.010	−0.002	−0.007	−0.002	0.004
	(1.31)	(0.75)	(0.09)	(0.30)	(0.53)	(0.97)
35	0.006	−0.003	0.009	0.007	0.001	−0.001
	(0.57)	(0.21)	(0.42)	(0.33)	(0.26)	(0.30)
36	0.011	0.017	0.003	−0.016	−0.003	−0.004
	(1.26)	(1.31)	(0.19)	(0.69)	(0.83)	(0.73)
Sum of Lags	0.986*	.115	2.034*	.289*	−0.298	−.044
	(2.38)	(1.82)	(2.33)	(2.00)	(1.74)	(1.28)
F[1]	2.24*	1.72*	1.10	1.16	1.10	1.12
$\bar{R}^2$	.40	.40	.24	.30	.24	.30
SEE	.6137	.6595	.6891	.7109	.6895	.7149

*Indicates statistical significance at the 5 percent level.

[1] F-statistic for the joint significance of the monetary variables.

Table 7
Results of the Davidson-MacKinnon J-test

Null/Alternative Hypotheses	Estimation Periods 1959.08–1987.06	1959.08–1973.09	1973.10–1987.06
$\Delta\dot{M}1/\Delta\dot{M}B$	–.87	.12	–1.02
$\Delta\dot{M}B/\Delta\dot{M}1$	3.78*	.33	3.58*
$\Delta\dot{M}1/\Delta N\dot{B}R$	3.15*	.20	2.53*
$\Delta N\dot{B}R/\Delta\dot{M}1$	3.36*	.31	3.03*
$\Delta\dot{M}B/\Delta N\dot{B}R$	3.59*	.18	3.02*
$\Delta N\dot{B}R/\Delta\dot{M}B$	–.86	.04	–.50
$(\Delta M1-\Delta M1^e)/(\Delta MB-\Delta MB^e)$	3.59*	.03	2.72*
$(\Delta MB-\Delta MB^e)/(\Delta M1-\Delta M1^e)$	.01	1.61	1.46
$(\Delta M1-\Delta M1^e)/(\Delta NBR-\Delta NBR^e)$	6.29*	2.83*	4.15*
$(\Delta NBR-\Delta NBR^e)/(\Delta M1-M1^e)$	–2.25*	0.53	–.75
$(\Delta MB-\Delta MB^e)/(\Delta NBR-\Delta NBR^e)$	6.22*	3.36*	4.25*
$(\Delta NBR-\Delta NBR^e)/(\Delta MB-\Delta MB^e)$	2.01*	–1.37	1.73

*Indicates statistical significance at the 5 percent level.

Estimates of Equation 13

As a further test of the robustness of the results to the model specification, equations of the general form of equation 13 are estimated. This specification has been estimated in such diverse ways and with such a wide array of regressors that an exhaustive evaluation is difficult. Instead, the approach here relies on the fact that this specification differs from the others primarily in that it has been estimated in *level*, rather than first-difference, form.[34] Some studies include measures of expected and unexpected inflation and unanticipated money growth; others include expected inflation, some measure of income growth, and a measure of the change in the growth rate of money. In the former studies, inflation expectations are generated as they are in the rational expectations models; in the latter, they are usually derived from survey data. Furthermore, Mehra (1985) and Wilcox (1983 a,b) measure the change in the money supply by the annualized growth rate of money over a shorter period relative to its growth rate over a longer period.

Consequently, two equations are estimated to capture the essence, if not the exact form, of variations of this specification. These equations are

$$(17)\ TBR_t = \alpha_0 + \sum_{i=1}^{6} \alpha_i TBR_{t-i} + \beta LIQ_t + \mu\Delta\dot{P}_t + \delta\Delta y_t + \lambda\dot{P}_t + \varepsilon_t$$

and

$$(18)\ TBR_t = \alpha_0 + \sum_{i=1}^{6} \alpha_i TBR_{t-i} + \beta(\Delta MV-\Delta MV^e)_t + \mu(\Delta P-\Delta P^e)_t + \delta(\Delta y-\Delta y^e)_t + \Delta P_t^e + \varepsilon_t.$$

LIQ is the negative of the difference between the annualized growth rate of M1 during the last three months and its annualized growth rate over the prior 12 months, $\Delta\dot{P}$ is the change in the growth rate of the price level and Δy is the change in level of the industrial production index. Because equation 18 includes ΔP_t^e, the estimated standard errors of ΔP_t^e from the usual two-step estimator of equation 18 are biased. Consequently, equation 18 is estimated using a full-information, maximum-likelihood (FIML) method used by Mishkin (1981, 1982).[35]

[34]One exception to this is Peek who, although he specified the equation in level form, appears to have estimated it in first-difference form. See Peek (1982) p. 986.

[35]Equation 18 is estimated simultaneously with the equations that generate the expected rates of monetary growth, inflation and real output growth, imposing the implied cross-equation restrictions. Also, because equation 18 includes a distributed lag of the level of TBR, the equations used to generate these expectations are modified to include the level of interest rates.

Table 8
Estimates of Equation 17

MV^u	Constant	LIQ	$\Delta \dot{P}$	Δy^1	$\dot{P}^1$	$\bar{R}^2$	SEE
			1960.05 – 1987.06				
M1	−.003	.034*	−.004	.067*	.040*	.970	.5141
	(0.04)	(4.25)	(0.37)	(3.38)	(3.92)		
MB	−.028	.051*	−.003	.077*	.042*	.970	.5185
	(.38)	(3.53)	(0.27)	(3.87)	(4.16)		
NBR	.035	−.003	−.003	.068*	.044*	.970	.5264
	(.047)	(1.67)	(0.29)	(3.30)	(4.23)		
			1960.05 – 1973.09				
M1	.145	.006	−.011	.006	.034*	.975	.2443
	(1.88)	(0.86)	(1.35)	(0.47)	(2.72)		
MB	.156*	.000	−.011	.006	.034*	.973	.2449
	(2.01)	(0.02)	(1.29)	(0.48)	(2.70)		
NBR	.151*	−.005	−.011	−.001	.032*	.974	.2420
	(2.01)	(1.93)	(1.29)	(0.10)	(2.55)		
			1973.10 – 1987.06				
M1	−.085	.042*	−.000	.131*	.049*	.944	.6732
	(0.44)	(3.27)	(0.01)	(3.34)	(3.04)		
MB	−.153	.091*	−.002	.144*	.052*	.947	.6703
	(0.79)	(3.48)	(0.09)	(3.72)	(3.31)		
NBR	−.046	−.002	.001	.146*	.056*	.940	.6947
	(0.23)	(0.81)	(0.06)	(3.55)	(3.43)		

[1]Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.
*Indicates statistical significance at the 5 percent level.

Table 8 presents estimates of equation 17.[36] The results indicate that interest rates show no statistically significant negative response; however, the coefficient for NBR for the pre-1974 period is nearly significant at the 5 percent level. The significant positive relation between LIQ and the level of the Treasury bill rate during the entire period, when either M1 or MB is the monetary variable, is attributable solely to the post-1973 period.

The magnitude of the coefficients on $\Delta \dot{P}$ and Δy and, in the case of Δy its statistical significance, depends on the period. The positive coefficient on $\dot{P}$ is statistically significant regardless of the sample period; however, the estimated magnitude of the coefficient is sensitive to the sample period.

Table 9 presents estimates of equation 18. Unanticipated inflation is significant in all three periods only when NBR is the monetary variable. Both unanticipated income and inflation are significant during the post-1973 period for all monetary variables. Surprisingly, anticipated inflation is signifi-

[36]Some econometric issues should be addressed because equations are estimated in both level and first-difference form. The issues center around whether the variables on both the left- and right-hand sides of the equations are stationary. If the right-hand-side variables are non-stationary, then the reported standard errors from the level equation will be incorrect even if the left-hand-side variable is stationary. On the other hand, if both the left- and right-hand-side variables are stationary, the reported standard errors from the first-difference specification will be inconsistent because the error term from this equation will be serially correlated. Most tests of macroeconomic time-series variables, like the ones used here, suggest that they are not stationary in the levels, e.g., Nelson and Plosser (1982); however, these tests are not powerful against the alternative hypothesis that the data are generated by a stationary AR process with close to a unit root. In this instance, estimates of the level equation would be appropriate, though the sample size necessary for appropriate inferences might be large. Because the objective is to see whether the results are sensitive to the specification of the equation, we are agnostic about whether the level or first-difference specification is "best."

Because of the lags involved in the construction of LIQ, it was necessary to shorten the estimation period for the first two periods. They begin at 1960.05, rather than 1958.07.

Table 9

FIML Estimates of Equation 18 for the three periods

MV^u	Constant	$\Delta MV - \Delta MV^e$	$\Delta P - \Delta P^e$ [1]	$\Delta y - \Delta y^e$ [1]	ΔP^e
			1959.08 – 1987.06		
M1	.060	−.008	.009	.008*	.069*
	(0.95)	(1.58)	(0.93)	(3.26)	(5.77)
MB	.054	.016	.050*	.011*	.018
	(0.81)	(1.94)	(4.51)	(4.31)	(1.46)
NBR	.081	−.011*	.039*	.009*	.013
	(1.24)	(6.68)	(3.71)	(3.65)	(1.03)
			1959.08 – 1973.09		
M1	.189*	.009	.014	.000	.059*
	(2.69)	(1.62)	(1.49)	(0.00)	(3.54)
MB	.183*	.003	.013	.001	.061*
	(2.55)	(0.48)	(1.28)	(0.42)	(3.73)
NBR	.144*	−.003*	.024*	.002	.024
	(2.08)	(2.10)	(2.51)	(1.09)	(1.58)
			1973.10 – 1987.06		
M1	−.188	−.027*	.105*	.021*	−.034
	(0.91)	(3.43)	(6.19)	(4.33)	(1.61)
MB	−.020	.036*	.083*	.021*	−.013
	(0.08)	(2.32)	(4.38)	(4.06)	(0.68)
NBR	.193	−.015*	.058*	.010*	.000
	(1.08)	(5.60)	(3.13)	(1.92)	(0.02)

[1]Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.
*Indicates statistical significance at the 5 percent level.

cant only during the pre-1974 period, and then only when M1 or MB is used.

With respect to the responsiveness of interest rates to monetary changes, the results are consistent with those reported in tables 1–6. A significant negative effect is obtained during all three periods only when NBR is the monetary variable. Moreover, the effect is larger during the post-1973 period, when a significant negative effect is also obtained with M1 as the monetary variable. Hence, the results are similar whether the interest rate is specified in level or first-difference form.

The Responsiveness of Interest Rates and Monetary Control

The responsiveness of interest rates should be greatest during periods when the Federal Reserve is attempting to control money. Since the Fed was attempting to control M1 through a nonborrowed-reserves operating procedure from October 1979 to October 1982, more precise estimates of the responsiveness of interest rates should be obtained during this period. The limited number of monthly observations prevents using specifications with a large number of parameters; however, the number of observations can be expanded by employing weekly data. The weekly time period has the added advantage that the responsiveness of interest rates to monetary changes is even less likely to be contaminated by income and inflation expectations effects.

Unfortunately, using weekly data precludes the income and price variables.[37] Previous results, however, indicate that a statistically significant

[37]Cunningham (1987) and Cunningham and Hardouvelis (1987) also use weekly data and proxy changes in prices by the BLS 22-commodity spot price index and income by unemployment claims. They acknowledge the weakness of these proxies and report no direct evidence consistent with a strong response of interest rates.

Table 10

Estimates of Equation 15 Using Monthly Data: 1979.10 – 1982.09

MV^u	Constant	MV^u	$yV^{u\dagger}$	$PV^{u\dagger}$	$\bar{R}^2$	SEE
$\Delta\dot{M}1$	.018	−.040*	.023	.086	.341	1.2533
	(0.08)	(2.03)	(1.13)	(1.49)		
	.002	−.038	—	—	.300	1.2930
	(0.01)	(1.88)				
$\Delta\dot{M}B$	.017	.007	.026	.069	.238	1.3485
	(0.07)	(0.15)	(1.17)	(1.06)		
	.008	.018	—	—	.215	1.3682
	(0.04)	(0.39)				
$\Delta\dot{N}BR$	.006	−.041*	.029*	.039	.610	.9650
	(0.04)	(4.98)	(1.84)	(0.88)		
	.004	−.041*	—	—	.576	1.0061
	(0.02)	(4.91)				
$(\Delta M1 - \Delta M1^e)$	.063	−.040	.021	.162*	.256	1.3320
	(0.28)	(1.09)	(0.79)	(1.78)		
	.006	.017	—	—	.218	1.3661
	(0.03)	(0.49)				
$(\Delta MB - \Delta MB^e)$	.029	.094	.046*	.164*	.398	1.1984
	(0.14)	(1.22)	(1.95)	(1.78)		
	.087	.157*	—	—	.323	1.2707
	(0.40)	(2.15)				
$(\Delta NBR - \Delta NBR^e)$	.109	−.053*	.035*	.106	.606	.9698
	(0.66)	(4.47)	(1.89)	(1.64)		
	.065	−.057*	—	—	.545	1.0416
	(0.37)	(4.53)				

†Since the coefficients on these variables are hypothesized to be positive, the significance tests are one-tailed.

*Indicates statistical significance at the 5 percent level.

effect is just as likely to show up in relatively simple and parsimonious specifications like equation 15. Also, the results indicate that the significance of the effect is relatively unaffected by the form of the unanticipated monetary variable. Consequently, specifications like equations 15 and 16 (without the price and income variables) can be used to estimate the responsiveness of interest rates to changes in the money stock with weekly data.

Estimates of equation 15 using monthly data for the period from 1979.10 to 1982.09 are presented in table 10. They are similar to those for the post-1973 period. When $\Delta\dot{M}1$ is the unanticipated monetary variable, the coefficient is negative and significant at the 5 percent level if unanticipated output and inflation are included, and marginally insignificant if they are not. For MB, the coefficient is positive and statistically significant only if $(\Delta MB - \Delta MB^e)$ is used and the other variables are excluded. When NBR is used, however, the coefficient is negative and highly significant regardless of whether the other variables are included. Furthermore, the estimated coefficients are larger than those obtained for the entire post-1973 period, and the adjusted R^2 is about twice that of the other monetary aggregates. These results are in keeping with the nonborrowed-reserves operating procedure used during the period. Nevertheless, the coefficients are small, indicating that a 1 percent increase in the growth rate of nonborrowed reserves results in an about four to six basis points decline in the monthly Treasury bill rate.[38]

Table 11 presents results using weekly data.[39]

[38]See Thornton (1988) for a discussion of the borrowed-reserves operating procedure.

[39]An equation similar to 16 was also estimated using weekly data. The results are not qualitatively different from those reported in table 11.

Table 11

Estimates of Equation 15 Using Weekly Data: October 3, 1979–October 6, 1982.

Monetary Variable	Constant	MV^u	$\bar{R}^2$	SEE
$\Delta\dot{M}1$	−.008	−.000	.085	.5843
	(0.18)	(0.30)		
$\Delta\dot{M}B$	−.008	−.000	.084	.5844
	(0.18)	(0.11)		
$\Delta N\dot{B}R$	−.008	−.000	.090	.5826
	(0.18)	(0.97)		
$(\Delta M1-\Delta M1^e)$	−.008	−.002	.088	.5831
	(0.18)	(0.82)		
$(\Delta MB-\Delta MB^e)$	−.008	−.001	.084	.5843
	(0.18)	(0.27)		
$(\Delta NBR-\Delta NBR^e)$	−.008	−.001	.098	.5801
	(0.18)	(1.50)		

*Indicates statistical significance at the 5 percent level.

There is no statistically significant response of equation 15 without the price and income variables, regardless of the monetary variable used. The results suggest that interest rates do not respond over a period as short as a week, but do respond over a period as long as a month.[40]

One possible reason for the disparity between the weekly and monthly results is that the data are averages of daily figures and the averaging process might mask the response of interest rates when weekly data are used.[41] Consequently, the equations using weekly data were re-estimated with the change in the Treasury bill rate measured by the difference in the Treasury bill rate on consecutive Wednesdays. Though not reported here, the results are qualitatively the same as those shown in table 11. Consequently, the insignificant response of interest rates is not due to averaging.

SUMMARY AND CONCLUSIONS

This article estimates the responsiveness of interest rates to monetary changes using alternative specifications that have been used in the literature and alternative monetary variables. The equations are estimated over the same time periods using the same data. Several interesting results emerge from this study.

First, estimates of the response of interest rates are relatively insensitive to the specification employed; they are, however, sensitive to the monetary variable used. A significant negative response of interest rates is most likely obtained if nonborrowed reserves is used as the monetary variable.

Second, a negative and statistically significant relationship between M1 or nonborrowed reserves and interest rates is more likely to be obtained during periods when the Fed was placing greater emphasis on monetary aggregates. The most consistent and statistically significant negative effect is obtained using nonborrowed reserves, a monetary variable that is likely to reflect the independent actions of the Federal Reserve. Nevertheless, the fact that there is a significant effect using nonbor-

[40]Hardouvelis (1987) estimates an equation similar to equation 16 using quarterly data for the period 1979.04 to 1982.03 and reports a very large negative and statistically significant effect of unanticipated money on the three-month Treasury bill rate. He finds no significant effect for the 11 quarters prior to 1979.04 or during the 12 quarters after 1982.03. He interprets this as evidence of a strong liquidity effect during the period when the Fed was targeting the money stock. Since he does not adjust for the credit controls during the first and second quarters of 1980, however, his atypically large interest rate response may be due to unusual movements in money and interest rates during these quarters. For example, the money stock decreased at a 5.9 percent annual rate during the first quarter of 1980, while the three-month Treasury bill rate increased by 316 basis points (measured as Hardouvelis does from the last month of the quarter). The money supply increased at a 21 percent rate during the second quarter of 1980 and the Treasury bill rate declined by 813 basis points.

[41]The monthly data used here are also averages of daily figures. Mishkin (1982) argues that misleading results about market efficiency can be obtained using averaged data, and reports that he obtained substantially worse fits when he estimated his equations using quarterly averaged data.

rowed reserves regardless of whether the Fed is concerned about the money stock or interest rates is anomolous.

Third, estimates of the responsiveness of interest rates are sensitive to the time period chosen. Generally, there is no statistically significant response of interest rates from 1958.08 to 1973.09 regardless of the monetary variable used. In contrast, a statistically significant negative effect is obtained using both M1 or nonborrowed reserves after 1973.09.

Fourth, the results are sensitive to the periodicity of the data. In particular, in the specifications estimated over the period from October 1979 to October 1982, there is a significant negative effect when monthly nonborrowed reserves are used, but not when weekly nonborrowed reserves are used.

Finally, the evidence shows that even when there is a significant negative response of interest rates, the measured response is small.

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